Chapter 11

Atmospheric Deposition of Pollutants of Concern

Aerial View of Industry Along River, Fox River, WI
Photograph by: Great Lakes Unlimited

Lake Superior Lakewide Management Plan
2000

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EXECUTIVE SUMMARY

Pollution control programs and remediation efforts throughout the Lake Superior basin over the past three decades have resulted in a cleaner, healthier ecosystem. However, the ecosystem is still recovering. As pollutant sources within the basin have been addressed and reduced, air deposition of critical pollutants has become a more significant source. In fact, long range atmospheric transport is now considered to be of greater significance in the Lake Superior basin than are local sources. For example, atmospheric deposition accounts for an estimated 82-95 percent of PCB loadings and 80-100 percent of dioxins/furans loadings to Lake Superior. The sources of these critical pollutants may be from as far away as Mexico and Central America, where many of the substances banned in the U.S. are still in use.

Several international pollution reduction strategies are underway, including work under the Binational Toxics Strategy, negotiations under the North American Commission for Environmental Cooperation, and negotiations on persistent organic pollutants under the Convention on Long Range Transboundary Air Pollution. Within the U.S., there is a vast array of regulatory programs aimed at reducing air emissions of critical pollutants. Some of these programs include the National Technology-Based Emission Standards, Integrated Urban Air Toxics Strategy, Great Waters Program, and the Persistent Bioaccumulative Toxics Initiative. In addition, there are many local initiatives throughout the Great Lakes basin, including Pesticides Clean Sweeps, the Michigan Mercury Pollution Prevention Task Force, and the Western Lake Superior Sanitary District pollution prevention efforts, to name just a few.

While there are a multitude of reduction strategies at all levels of government, as well as industry and other private initiatives, there are still many data gaps which hinder continued reductions in loadings to Lake Superior. These data gaps include inventories of existing sources, fate/transformation processes of chemicals after release to the air, and information on the significance of air deposition of critical pollutants to land within the watershed. In addition to filling the data gaps, there are many policy recommendations and actions which U.S. EPA can take on national and international levels to further reduce atmospheric deposition of critical pollutants to Lake Superior. Such policy items include encouraging states to take innovative measures to address local air sources of targeted pollutants and supporting and pursuing activities to reduce mercury emissions.

Figure 11-1. Action Summary

Project Title	Lead Agency/ Funding Source	Funded	Needs Funding
Fund pollution prevention projects such as dioxin burn barrels, mercury reduction and/or elimination efforts (such as the American Hospital Association's MOU with U.S. EPA), that will lead directly to reduce inputs to the atmosphere.	U.S. EPA, Lake Superior states	X	
Fund Clean Sweep Programs which directly prevent the inputs of banned or cancelled pesticides into the Great Lakes basin and watershed by sponsoring pesticide collection programs.	U.S. EPA, Lake Superior states	X	
Continue to participate in inter and intra agency work groups and forums which deal with the long-range transfer of atmospheric deposition. Such groups include the Persistent Bioaccumulative and Toxic Strategy (PBT) POPs interagency task force, the United Nations group on long-range transport, the Great Lakes Binational Toxics Strategy, and the North American Commission for Environmental Cooperation.	EC and U.S. EPA	X	
U.S. EPA will provide funding to support workshops in at least one Lake Superior Basin state on how to reduce the use of mercury-containing devices at electric utilities.	U.S. EPA	X	
U.S. EPA will develop and distribute through the Binational Toxics Strategy mercury workgroup a package of information related to mercury reduction at schools, including advice on how to eliminate mercury from school laboratories.	U.S. EPA	X	
Better coordination among the Lakes and the LaMPs on atmospheric deposition efforts. Such actions might include working with the Lake Michigan Commission, the LaMP and the Delta Institute's work on atmospheric deposition.	U.S. EPA, the Delta Institute, Lake Superior states	X	

Figure 11-1. Action Summary

Project Title	Lead Agency/ Funding Source	Funded	Needs Funding
U.S. EPA commits to ensuring that all Region 5 states will have enforceable regulations and the permit applications that are required to be submitted for municipal waste combustors and for hospital/medical/infectious waste incinerators by December 2000. Moreover, U.S. EPA commits to pursuing a strategy for assuring 100 percent compliance with these regulations. As regulatory deadlines approach for installation of needed emissions controls, compliance will lead to significant reductions of various pollutants of concern, including mercury. This strategy will involve close coordination, including an effort to expedite State rulemaking as appropriate.	U.S. EPA	X	
U.S. EPA Region 5 will support the rigorous development and refinement of the Regional Air Toxics Emissions Inventory of all hazardous air pollutants, including those of concern to the Great Lakes and other inland water bodies and which have a tendency to bioaccumulate. U.S. EPA will work closely with all eight Great Lakes states to assure every possible known source of all magnitudes of emissions are identified and that good emission estimates are developed and updated to reflect implementation of control technologies and progress in emission reductions for input to air dispersion and deposition models. This will ensure that a process can occur to assure that regulations and/or P2 initiatives can be developed for environmental improvement.	U.S. EPA, DNR, MN DNR, MI DNR	X	
U.S. EPA will make a determination about whether to regulate mercury emissions from electric utilities.	U.S. EPA	X	
U.S. EPA will complete the pilot projects to establish TMDL allocations for two waterbodies receiving mercury from atmospheric deposition in order to evaluate the integration of air and water program technical tools and authorities and to examine emission reduction options.	U.S. EPA, WI DNR	X	

Figure 11-1. Action Summary

Project Title	Lead Agency/ Funding Source	Funded	Needs Funding
The U.S. EPA has committed approximately $6 million in FY 2000 and FY2001 funds to support mercury research in a number of priority areas including transport, transformation and fate; and human health and wildlife effects of methyl mercury. These research activities are aimed at reducing the uncertainties currently limiting the Agency's ability to assess and manage mercury and methylmercury risks. A particular target of research will be collection and analysis of information on mercury emissions and control options for coal-fired utilities in order to support OAR's mandate for a regulatory determination on mercury controls for utilities by December 15, 2000.	U.S. EPA, ORD	X	
In November 1999, U.S. EPA filed civil complaints against seven electric utility companies operating coal-fired power plants in the Midwest and Southeast, charging that 32 of their plants failed to control emissions of oxides of nitrogen and sulfur as required under provisions applicable to modified sources under the Clean Air Act. Resolution of these complaints could provide an opportunity to promote solutions that reduce emissions of mercury and other pollutants, as well as of nitrogen and sulfur.	U.S. EPA, U.S. Department of Justice	X	

11.0 ABOUT THIS CHAPTER

This section of the Lake Superior LaMP 2000 Document presents a brief overview of the problem of atmospheric deposition of pollutants to the Great Lakes. It is not a comprehensive, technical report of the problem but rather focuses on the broad scientific and programmatic aspects relevant to the Great Lakes. Where available, Lake Superior-specific information is presented. When not, broader Great Lakes basin-wide information is presented.

This section also describes national and Great Lakes specific programs and activities that have directly or indirectly contributed to reducing loadings and exposures for many of the Lake Superior nine critical pollutants. It also presents possible policy recommendations and actions for addressing these out-of-basin sources.

11.1 INTRODUCTION

Water quality conditions in the Great Lakes are greatly improved compared to a few decades ago, the result of environmental regulatory programs and public and industrial cleanup efforts addressing primarily waterborne pollution. However, despite the improvements, the Lake Superior ecosystem is still recovering, and it is necessary to address the more diffuse sources of pollution, including the air component, in order to attain water quality goals and to ensure protection of human health and the environment.

The role of the air pollution as an important contributor to water pollution has long been recognized and, in recent years, has been the subject of growing scientific study and concern. Over the past 3 decades, scientists have collected a large and convincing body of evidence showing that toxic chemicals released into the air can travel long distances and be deposited on land or water at locations far from their original sources. Some of the early scientific studies of air deposition are described below:

- Studies of fish from Siskiwit Lake - a small lake on an island in northern Lake Superior that is isolated from most human influences - have shown contamination with polychlorinated biphenyls (PCBs), toxaphene, and other pesticides, which have no known sources on the island. Toxaphene, a pesticide banned in the U.S. in 1982, had limited use in the Lake Superior region but was used heavily in the southeastern U.S. Cotton Belt from the late 1960s to the mid-1970s. The use pattern implies toxaphene found in the Great Lakes was probably transported by air from the Southeast to the Great Lakes region. Airborne levels of toxaphene are highest in the southeastern U.S. and decline with distance as one moves toward the Great Lakes and north Atlantic regions.

- Air and rainfall in the Great Lakes region have repeatedly been shown to be contaminated with a variety of toxic chemicals. The Integrated Atmospheric Deposition Network (IADN) has monitored elevated levels of PCBs, polycyclic aromatic hydrocarbons (PAHs), lead and a number of chlorinated pesticides in rainfall and the atmosphere since 1991 on each of the Great Lakes.

- A series of studies of Wisconsin lakes indicate that the air is a major contributor of mercury to these lakes and that modest increases in air deposition of mercury could lead directly to higher levels of mercury in fish.

- It is likely that other pesticides present in the Great Lakes, including DDT, are transported long distances by the air, from their sources to the Great Lakes region. Based on the amount and chemical form of DDT present in core samples from peat bogs in the Great Lakes region, new releases of DDT are apparent and may be originating from sources outside the U.S., possibly Mexico and Central America. Atmospheric deposition of DDT, toxaphene, HCB, and PCB in the Great Lakes region, as measured in peat cores, are consistent with the U.S. production and use history of these chemicals.

These examples, along with many similar discoveries - including the much-studied phenomenon of acid rain - provide convincing evidence that long-distance atmospheric transport is an important global pathway for the distribution of some of the pollutants of concern. Perhaps most notably, it appears that PCBs and some other persistent pollutants, including several pesticides that have not been used in significant amounts in the U.S. since the 1970s, have become widely distributed in the environment and are now, in essence, part of the global "background." These toxic chemicals remain in our environment and continue to cycle between air, water, soil, and biota even after their manufacture, use, or release has stopped.

Although these studies have documented the importance of long-range transport for some pollutants of concern (e.g. PCBs and chlorinated pesticides), more recent ongoing studies point to influence of local sources, particularly nearby urban areas, on loadings to the Great Lakes. In order to quantify the total atmospheric load, it is important to consider both long-range and local sources. The relative importance of each source to the overall loading to the Great Lakes is variable depending on the pollutant and the Lake. For Lake Superior, it is thought that the long range transport of pollutants which affect the Lake is of greater significance than local or regional sources due to the limited number of identified atmospheric sources of critical pollutants in the region. For Lake Michigan, it is thought that the Chicago-Gary urban area also contributes to the loadings of PCBs, PAHs and mercury to the entire Lake.

Transport distances depend on the characteristics of the chemicals and source emissions as well as weather patterns. Scientists have long recognized the basic processes by which air pollutants can enter rivers, lakes, and other waterbodies. The steps in this process are described below and illustrated in Figure 11-2 below.

- First, pollutants are *released* to the air from a source, which may be natural or anthropogenic. Anthropogenic sources include point sources, such as industrial smokestacks or any other fixed location that releases pollutants, area sources, such as pesticide applications on agricultural fields, and mobile sources, such as exhaust from automobiles. Natural sources include forest fires, volcanic eruptions, and windblown dust. Pollutants can be released as either gases or as particles.

- Second, pollutants released to the air are *transported* away from their source to other locations. Depending on weather conditions and the chemical and physical properties of the pollutant, air pollutants may be transported either short or long distances from their sources and may under physical and chemical changes while in transit.

- Third, air pollutants are *deposited* to the earth, in most cases directly to a waterbody or to a land area that drains into a waterbody. Pollutants are deposited by "wet deposition" or "dry deposition". In wet deposition, pollutants are removed from the air by a precipitation event such as rain or snow. Dry deposition occurs when particles settle out of the air and into water. Air pollutants can also enter a waterbody indirectly, by first depositing onto surrounding land or tributaries and then moving into the waterbody by other routes, such as stormwater runoff or inflow from tributary streams.

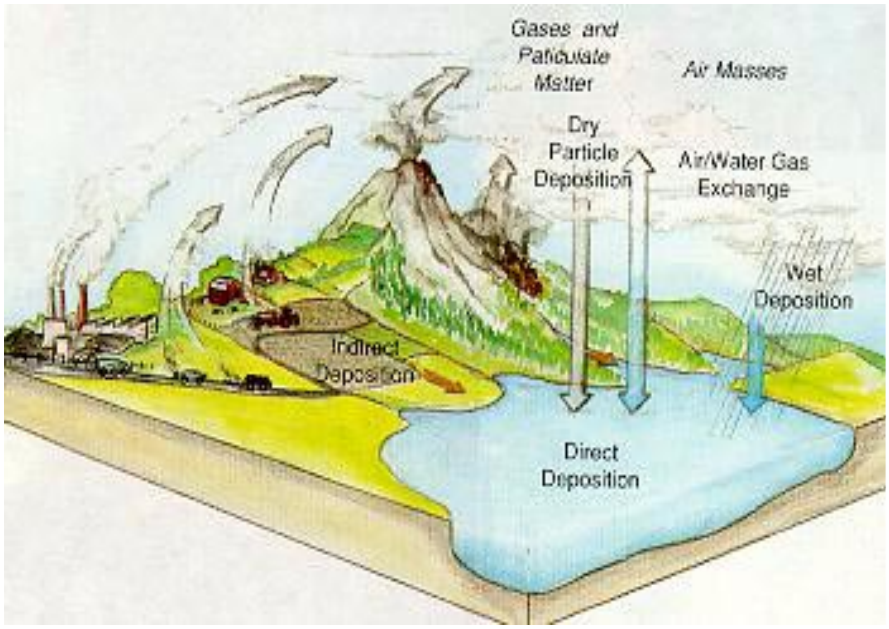

Figure 11-2. Air Deposition Processes

11.2 CURRENT UNDERSTANDING

Although the extent of anthropogenic contribution of pollutants of concern to human health and environmental effects associated with exposures to these pollutants has not yet been fully quantified, a "plausible" link exists between emissions and the concentrations of these pollutants found in sediment, water, and fish. The very fact that atmospheric transport of some pollutants can occur over long distances (even globally) makes the confirmation of this link all the more difficult because of the large number of sources that need to be quantified.

But even with the difficulties in linking emissions from air sources to water quality problems, much progress has been made over the past few years to better understand the science of atmospheric deposition. Some of the more recent scientific findings are described below.

- According to data collected under IADN, atmospheric deposition of lead, cadmium, PCBs, DDT/DDE, and dieldrin to the Great Lakes has continued to decline in recent years. For some of the banned pesticides (including chlordane, toxpahene and lindane), atmospheric deposition levels have remained relatively unchanged or increasing in recent years.

- Despite recent declines, atmospheric deposition continues to be a significant contributor of certain pollutants to the Great Lakes. In Lake Superior, approximately 82-95 percent of the PCBS entering the Lake are from atmospheric inputs (Dolan and others 1993, Hoff and others 1996), and approximately 80-100 percent of the dioxins/furans entering the Lake are from atmospheric deposition (Cohen and others 1995, Pearson and others 1998).

- U.S. EPA's Mercury Report to Congress (1997) noted the 1994-1995 mercury contribution from U.S. anthropogenic sources to the atmosphere was 158 tons, of which 87 percent was from combustion sources (waste incineration, utility fossil fuel plants). Estimated total annual input from all mercury sources was 5,500 tons world-wide, indicating that U.S. anthropogenic sources represent only 3 percent of global releases in 1995. Fifty-two tons (33 percent) of U.S. source emissions of mercury are deposited within the U.S. borders, while the remaining two-thirds (107 tons) are transported beyond U.S. borders, where they diffuse into the global reservoir. Depositional input to the U.S. from non-U.S. sources of mercury was estimated at 35 tons. Although, the computer simulation on which these estimates were developed has recognized uncertainty which needs to be resolved by additional data, nevertheless it appears that solutions to the mercury problem will require an international effort.

- Preliminary results from the Lake Michigan Mass Balance Study (LMMB) suggest that approximately 84 percent of the total mercury input to Lake Michigan is contributed by atmospheric deposition (wet and dry deposition, and air-water exchange); whereas, tributary inputs of mercury accounted for 16 percent of the total mercury input to the Lake. Using a hybrid receptor model, localized urban sources, in and around Chicago, contributed approximately 19 percent of the total atmospheric loading to the Lake. (Landis 1998)

- In a study by Pirrone and others (1998), air deposition was found to be the major contributor of mercury to the Great Lakes as indicated by sediment core analysis of mercury deposition rates over time. Atmospheric deposition fluxes in the Great Lakes were estimated to be almost an order of magnitude higher than the pre-industrial average to the whole of North America.

- Modeling results using HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) estimate that approximately 75 percent of deposition to the 5 Great Lakes from air pathways originates from within the Great Lakes States and Provinces. In considering sources of atmospheric deposition of dioxin to Lake Ontario, approximately 50 percent appears to

originate from sources in close proximity to the Lake, while the balance occurs from sources at a much greater distance (400-1500 km). For Lake Superior, transport of dioxin from outside the region is relatively more important (40 percent of deposition from sources between 400 - 700 km), since there are few immediately adjacent upwind sources. This finding is also applicable to Lake Huron. (An International Joint Commission 1997-1999 Priorities Report)

- Emissions and numbers of U.S. anthropogenic sources have declined for mercury, lead, dioxins/furans, and the banned and restricted use substances. For example, lead emissions in the Great Lakes region declined at a rate of 6.4 percent per year from 1982 to 1993 reflecting the national decline in lead emissions resulting from the phase-out of leaded gasoline in automobiles.

- Emissions from U.S. anthropogenic sources have remained constant or are variable for cadmium and polycyclic organic matter (POM)/PAHs.

- The sources of atmospheric deposition vary, depending on the pollutant. As an example, sources of atmospheric mercury which is deposited include emissions from industrial and combustion sources, emissions from natural sources such as volcanoes, and re-emission from mercury-contaminated soils and water. These sources can be in the U.S. or other countries, and the mercury emissions can be deposited near the source or transported long distances across international borders. However, some point sources emit significant amounts of reactive chemical forms of mercury which are primarily deposited locally. Determining the complete picture of atmospheric deposition to the Great Lakes requires ascertaining the contributions of each of the relevant sources.

- Local sources, including urban area, can have a large impact on local pollutant deposition rates. Recent research under the Atmospheric Exchange Over Lakes and Oceans Study (AEOLOS) project continues to show that the diffuse emissions of urban areas can significantly affect nearby deposition rates. For example, deposition rates of PCBs and PAHs have been found to be elevated over southern Lake Michigan near the Chicago urban area. Therefore, estimates of pollutant loadings and net flux at the waterbody-scale are sensitive to the placement of monitoring sites.

- The pesticide atrazine is found to be ubiquitous in the Great Lakes, due to heavy use within the eastern cornbelt of Illinois and Indiana. Lake Superior is the only Great Lake for which deposition from the atmosphere is the dominant atrazine input.

- Toxaphene is important due to relatively high levels present in fish in Lake Superior. Both transport and a local source in the Lake Superior/Michigan area may be responsible for the previously high levels found in lake fish. Water concentrations are declining since it was canceled in the early 1980s.

- Available monitoring data indicate that concentrations of dioxins/furans and PCBs, in the sediment, water, and biota of several of the Great Lakes appear to be declining, while

concentrations of lead, cadmium, mercury, and POM/PAHs are too variable to discern a trend. For example, concentrations of PCBs in biota have continued to decline in the Great Lakes.

- Based on current atmospheric research by Cortes and others (1998) on atmospheric pollutant concentrations in the Great Lakes region, DDT and DDE, followed by dieldrin and chlordane, are estimated to fall below current detection limits in the atmosphere between 2010 and 2020. HCH and HCB are projected to be eliminated in the atmosphere by 2030 and 2060, respectively. These estimates assume current rates of long-range transport of these pollutants into the region. It should be noted that elimination of these pollutants in the atmosphere does not, because of their persistence, mean that concentrations would be eliminated in deposited media by these dates. However, these estimates indicate that reduction strategies in the Great Lakes, along with the original bans or restrictions on the use of these substances, are having the intended effect.

- Loadings of canceled or restricted pesticides to the Great Lakes are primarily from sources that are difficult or may not be practical for U.S. EPA, EC, States, Tribes, or others to further regulate. Although there are no major sources of banned pesticides in the U.S., loadings continue from remaining consumer stocks, evaporation from soils, resuspension of contaminated sediments, and airborne transport from other countries which have not yet canceled these substances. Future reductions most come from clean up of existing stockpiles and contaminated sites and reductions in airborne pollutants transported from other countries.

11.3 INTERNATIONAL, NATIONAL AND LOCAL EFFORTS TO REDUCE AIR TOXICS

Many international, national, basin-wide and local efforts are currently underway to address the complex and multifaceted air deposition problem. Some of these programs are highlights below:

11.3.1 International Efforts

Among notable international efforts to reduce the use or seek the elimination of persistent toxic contaminants are the activities of the North American Commission for Environmental Cooperation (CEC) and the Persistent Organic Pollutants (POPS) agreement negotiations conducted under the Convention on Long-Range Transboundary Air Pollution (LRTAP) adopted by the United Nations Economic Commission for Europe. The CEC is an ancillary agreement to the North American Free Trade Agreement (NAFTA) adopted by the three North American countries in 1994.

The development of remedial action plans for mercury, chlordane, DDT and PCBs and the Continental Pollutant Pathways project emphasize the recognized importance of long range transport issues. Much effort, however, remains in order to adequately implement an effective solution. The POPS accord, like the CEC initiative, relies upon information exchange to achieve its objectives.

The Great Lakes Binational Toxics Strategy provides a framework for actions to reduce or eliminate persistent toxic substances from the Great Lakes basin. This Strategy targets almost the same subset of critical pollutants as the Lake Superior LaMP, and has of particular focus on sources (both in-basin and out-of-basin) that impact the Great Lakes. The Binational Strategy can helped the Lake Superior LaMP leverage resources to better address atmospheric deposition in a variety of international forum.

11.3.2 United States Regulatory Programs to Reduce Air Toxics

There are a range of federal regulatory programs that provide authorities to either directly or indirectly reduce emissions, restrict product use, and increase our understanding of or remove from the environment pollutants of concern.

11.3.2.1 The Clean Air Act

In 1990, Congress amended the Clean Air Act (CAA) by adding a phased approach to regulate air toxics. This phased approach reflects the mandates under the CAA to first develop technology-based air toxics regulations and then subsequently to implement a more risk-based program. Other sections of the CAA call for study of specific types of air toxics problems including a focus on certain toxic air pollutants that persist and bioaccumulate in the environment. U.S. EPA has developed an Action Plan for the National Air Toxics Program to describe the variety of activities underway within the air toxics program, identify interrelationships among activities and highlight timeframes for products and opportunities for public participation. The action plan is divided into 4 components:

- Source and sector-specific standards
- Multi-media Projects and Risk Initiatives
- National Air Toxics Assessments
- Education and outreach.

Source and Sector-Specific Standards

- National Technology-Based Standards - Under the CAA Amendments of 1990, U.S. EPA is required to develop standards for each of the 174 stationary sources that emit one or more of the 188 identified hazardous air pollutants. These standards, known as Maximum Achievable Control Technology (MACT) standards, are based on the emissions levels that are already being achieved by the better controlled sources in an industry. To date, U.S. EPA has promulgated 44 emission standards covering 79 source categories. These standards are responsible for annual reductions of approximately 1.5 millions tons of air toxics and 2.5 million tons of VOCs. Over the next 3 years, U.S. EPA plans to promulgate additional emission standards, which should achieve annual reductions of another 0.5 million tons.

- Combustion Standards - Under Section 129 of the CAA, U.S. EPA has also issued 2 final rules to control emissions of certain toxic pollutants from certain types of solid waste

combustion facilities. These rules set emission limits for new solid waste combustion facilities and provide emissions guidelines for existing solid waste combustion facilities. These rules affect municipal waste combustors and hospital/medical/infectious waste incinerators, which account for 30 percent of the national mercury emissions to the air. By the time these rules are fully implemented, they are expected to reduce mercury emissions from these sources by about 90 percent from current levels, and reduce dioxin/furan emissions from these sources by more than 95 percent from current levels. U.S. EPA is working on additional rules to address industrial and commercial waste incinerators, other solid waste incinerators and small municipal waste combustor units.

- Residual Risk Standards - The residual risk program is designed to assess the risk remaining from stationary source categories after U.S. EPA implements a technology-based standard. U.S. EPA is required to set additional standards if the level of "residual risk" does not provide an "ample margin of safety to protect public health" or if further emissions reductions are needed "to prevent, taking into consideration costs, energy, safety, and other relevant factors, an adverse environmental effect." These residual risk standards are required within 8 years (9 years for the earliest standards) after U.S. EPA finalizes the technology-based standard.

- Area Source Standards - Under the Integrated Urban Air Toxics Strategy, U.S. EPA must ensure that 90 percent of the area source emissions of the 30 "area source" urban air toxics listed in the Strategy are regulated. In order to accomplish this, U.S. EPA identified 13 new source categories of smaller commercial and industrial operations or so-called "area" sources for regulation. U.S. EPA plans to finalize regulations for these area source categories by 2004. U.S. EPA has completed or nearly completed regulations on an additional 16 area source categories. However, the Agency will be adding source categories to that list for regulation to meet the requirement to regulate 90 percent of the area source emissions.

- Seven Specific Pollutants - The Act also lists seven specific pollutants (alkylated lead compounds, POM, hexachlorobenzene, mercury, PCBs, 2,3,7,8-tetrachlorodibenzofurans [TCDF] and 2,3,7,8-tetrachlorodibenzo-p-dioxin [TCDD]) for special attention by the U.S. EPA. The Act requires that U.S. EPA assure that sources accounting for 90 percent of the emissions of these toxics are subject to regulation. On April 3, 1998, U.S. EPA issued the list of additional source categories. They are (1) open burning of scrap tires (for POM); and (2) gasoline distribution Stage I Aviation, includes evaporative losses associated with the distribution and storage of aviation gas containing lead (for lead). U.S. EPA plans to complete these standards by 2003.

- Utility Determination and Actions - U.S. EPA is continuing to gather data on the mercury emissions from coal-fired electric utility power generation plants to evaluate the need for regulation of toxic air pollutants from these sources. Utility plants (primarily coal-fired plants) emit approximately 50 tons per year of mercury nationwide, which is almost 1/3 of the manmade mercury emissions in the United States. U.S. EPA will make a determination on whether to regulate air toxics emissions from electric utilities by December 2000.

- Mobile Source Standards - U.S. EPA started enforcing the first federal emission standards for passenger cars in 1968. Since then, the Agency has developed emission standards for all types of highway vehicles, their fuels, and engines used in virtually all varieties of mobile or portable nonroad equipment such as tractors, construction vehicles, recreational and commercial vessels, and lawn and garden equipment. U.S. EPA has made the emission standards more stringent over time. In May of this year, U.S. EPA proposed stringent new standards for all cars and light duty trucks, and the gasoline they use. At the same time U.S. EPA issued an advance notice of proposed rulemaking to solicit information relating to control of diesel fuel quality. This year, U.S. EPA is reviewing standards for heavy-duty highway vehicles and engines for 2004, and considering new emission standards for these vehicles and engines beyond 2004. U.S. EPA is also reviewing standards for nonroad diesel engines.

While the toxic reductions from U.S. EPA's mobile source emission standards have been large, prior to 1990 U.S. EPA had no specific directions from Congress for a planned program to control toxic emissions from mobile sources. However, in 1990 Congress amended the Clean Air Act, adding a formal requirement to consider motor vehicle air toxics controls. Section 202(l), requires the Agency to complete a study of motor vehicle-related air toxics, and to promulgate requirements for the control of air toxics from motor vehicles based on that study. U.S. EPA completed the required study in 1993, and is presently conducting analyses to update emissions and exposure analyses done for that study, and is currently working on a rulemaking to address these requirements.

Multi-Media Projects and Risk Initiatives

- Great Waters - The Act directs U.S. EPA to monitor, assess and report on the deposition of toxic air pollutants to the "Great Waters," which include the Great Lakes, Lake Champlain, Chesapeake Bay and other coastal estuaries. Activities include assessing deposition to these waters by establishing a deposition monitoring network, investigating sources of pollution, improving monitoring methods, evaluating adverse effects, and sampling for the pollutants in aquatic plants and wildlife. Pollutants of concern to the Great Waters include mercury, lead, cadmium, nitrogen compounds, POM/PAHs, dioxins and furans, PCBs, and seven banned or restricted pesticides.

- Mercury Total Maximum Daily Load (TMDL) Air Deposition Pilot Project - The Great Waters program is multimedia in nature and requires cross-program approaches to investigate and address problems. U.S. EPA's air and water programs are working together on 2 pilot studies to address mercury deposition to waterways, and the outcome of this effort will influence the development of joint national guidance for addressing TMDLs where air deposition is a factor. The 2 waterbodies on which the pilot is being conducted are Devil's Lake in Wisconsin and a portion on the Florida Everglades. For each of the pilot waterbodies, the project will evaluate techniques for determining the amount of mercury reductions needed to meet water quality standards; and determining the relative contributions of mercury from various sources, source categories, and source regions. The project will also analyze Federal and State regulatory and non-regulatory tools for reducing mercury emissions

that may be causing water quality problems. Pilot TMDLs will be developed for each of the study areas. In addition, U.S. EPA plans to issue a report on lessons learned from both pilots upon completion of the projects.

- Air - Water Interface Action Plan - The action plan is intended to consolidate the Agency's efforts to understand and address atmospheric deposition nationwide, including the Great Waters and other State-identified impaired waterbodies. The plan should include: targeting State-identified impaired waterbodies; examining what rules or activities are in place that address impairment caused by air deposition; and determining what, if any, additional actions are necessary to address impairment caused by air deposition. To date, OAR and OW management have held 2 meeting with Great Lakes environmental groups to discuss various components of the action plan including TMDLs, upcoming MACT standards, and air toxics monitoring. A draft plan will be developed for external review in the summer of 2000.

- Integrated Urban Air Toxics Strategy - The urban strategy contains the same components of the overall air toxics strategy; however, it has risk-based goals for addressing air toxics in urban areas. Specifically, the Strategy has 3 goals for urban areas nationwide. The first to ensure a 75 percent reduction in cancer incidence from stationary sources. The second to ensure a "substantial" reduction in health risks from area sources. The third to ensure that disproportionate risks are addressed first, thus focusing our efforts for sensitive populations or where there are geographic hot spots.

- Urban Community-Based Pilot Projects - Since air toxics exposures vary (in terms of pollutants and sources) between urban areas across the country, U.S. EPA's activities to reduce risk on the national scale may not address potential risks on the more local level. Consequently, the Strategy includes local and community-based initiatives which U.S. EPA envisions will involve partnerships between U.S. EPA and the State, local and Tribal governments.

- Mercury Initiatives - The Act requires U.S. EPA to issue a report on the sources and impacts of mercury. U.S. EPA released the *Mercury Report to Congress* in December 1997. The report includes an assessment of the emissions of mercury from all known anthropogenic sources in the United States, the health and environmental implications of these emissions, and the availability and cost of control of these emissions. The report supports a plausible link between anthropogenic releases of mercury from industrial and combustion sources in the United States and methylmercury in fish.

- Mercury Research Strategy - U.S. EPA's Office of Research and Development's (ORD) *Mercury Research Strategy*, seeks to address the scientific mercury questions of greatest concern through a coordinated research program. There are two key fate and transport questions the strategy seeks to address. First, how much methylmercury in fish is contributed by U.S. sources relative to other natural and global sources? Second, how much, and over what time frame, will levels of methyl mercury in fish in the U.S. decrease as the result of reductions made by U.S. sources?

- Coordination Initiatives - U.S. EPA has a number of activities to identify and address risks from specific types of pollutants. The Persistent Bioaccumulative Toxics (PBT) Initiative seeks to further reduce risks to human health and the environment from existing and future exposure to persistent, bioaccumulative and toxic pollutants through a coordinated effort between U.S. EPA offices, and other Federal and State and local agencies. Another interagency and multimedia strategy is the Clean Water Action Plan (CWAP). The CWAP seeks to address the remaining obstacles to the Clean Water Act's original goal of "fishable and swimmable" water for all Americans. The Plan identifies non-point sources, including atmospheric deposition, as the most important remaining threat to water quality.

National Air Toxics Assessment Activities

National air toxics assessment (NATA) activities are a primary component of U.S. EPA's national air toxics program. Over time, these activities will help us set program priorities, characterize risks, and track progress toward meeting the goals of the national air toxics program, as well as specific risk-based goals. More specifically, NATA activities broadly include expanding air toxics monitoring, improving and periodically updating emissions inventories, periodically conducting national- and local-scale air quality, multi-media and exposure modeling, characterizing risks associated with air toxics exposures, and continued research on health and environmental effects and exposures to both ambient and indoor sources of air toxics. U.S. EPA is now conducting an initial screening-level assessment to demonstrate our approach to characterizing air toxics risks nationwide. Other planned assessments include pollutant-specific activities such as the Dioxin Reassessment and Action Plan and a proposed National Air Deposition Assessment.

Education and Outreach

U.S. EPA believes that public participation is vital for the implementation of the overall air toxics program. The Agency is committed to working with cities, communities, State, local and Tribal agencies, and other groups and organizations that can help implement activities to reduce air toxics emissions. For example, the Agency expects to work with the cities and other interested stakeholders on the national air toxics assessments, on regulation development, and on the urban community-based pilot projects. Other outreach and education efforts include:

- Great Waters Program Outreach - The CAA directs U.S. EPA to periodically report its findings related to the results of any monitoring, studies and investigations conducted under this program. The U.S. EPA has already submitted a *First* and *Second Report to Congress* and is in the process of completing the *Third Great Waters Report to Congress*. U.S. EPA is also working on additional outreach tools for the public such as an educational brochure to inform the public about air deposition issues and further enhancements to Great Waters websites. During 2000, U.S. EPA will be developing a handbook to assist water resource managers in understanding how to characterize air deposition problems.

- Urban Air Toxics Report to Congress - U.S. EPA is required under the CAA to provide 2 reports to Congress on actions taken to reduce the risks to public health posed by the release of toxic air pollutants from area sources. The CAA also requires that the reports identify specific metropolitan areas that continue to experience high risks to public health as a result of emissions from area sources. U.S. EPA will complete the first of these 2 reports in late 1999. The second report is due in 2004.

11.3.2.2 The Clean Water Act

Under the Clean Water Act (Section 303(d)), U.S. EPA focuses on identifying and restoring the Nation's polluted waterbodies. Under this authority, States are directed to (1) identify and list waterbodies where State water quality standards are not being met and (2) establish TMDLs for those waters. TMDLs specify the amount of a pollutant that may be present in the water and still allow the waterbody to meet State water quality standards. TMDLs allocate pollutant loads among pollution sources (e.g., point and nonpoint sources), and include a margin of safety that accounts for uncertainty in the relationship between pollutant loads and characteristics of the waterbody. Air deposition is considered a non-point source load. U.S. EPA is developing the science and tools to assess the contribution of atmospheric sources to water pollution and to assist in decreasing total pollutant loadings to waterbodies. TMDLs are not directly implemented or enforceable against sources in a watershed. Rather, they are implemented through other Federal, State, Tribal, and local authorities, such as point source discharge permits, federal land management plans, State nonpoint source programs, and local zoning programs.

11.3.2.3 Toxic Substances Control Act (TSCA)

TSCA provides U.S. EPA with the authority to regulate and control existing and new chemical substances and mixtures that pose a risk to human health or the environment. This Act bans the manufacture, processing, distribution in commerce, and use of PCBs except in totally closed systems and establishes rules for disposal of PCBs.

11.3.2.4 Resource Conservation and Recovery Act (RCRA)

Congress enacted RCRA in 1976 due to concern over the "disposal of solid and hazardous waste in or on the land without careful planning and management."

11.3.2.5 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA was enacted in 1980 to aid U.S. EPA in responding to releases and threatened releases of hazardous substances from waste disposal sites. CERCLA was amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA). Hazardous substances included all pollutants, wastes and substances also regulated under the CAA, CWA, RCRA and TSCA.

11.3.2.6 Emergency Planning and Community Right-to-Know Act (EPCRA)

EPCRA requires local and State governments to develop plans to prevent, prepare for and respond to chemical accidents. EPCRA also established the Toxics Releases Inventory (TRI). The TRI requires covered facilities to report annual releases and U.S. EPA to maintain a public database of the information reported.

11.3.2.7 Mercury-Containing and Rechargeable Battery Management Act of 1996 (MCRBMA)

The MCRBMA phases out the use of mercury in batteries and provides for the efficient and cost-effective collection and recycling or proper disposal of used nickel cadmium batteries, small sealed lead-acid batteries, and certain other batteries. This legislation prohibits deliberate inclusion of mercury into alkaline-manganese batteries, zinc-carbon batteries, and button cell mercuric oxide batteries. This prohibition does not include mercury contained incidentally in other materials included in batteries, and includes an exception for alkaline-manganese button cells, which are limited to 25 milligrams of mercury per button cell. Non-button cell mercuric oxide batteries may include mercury only if the manufacturer identifies sites for proper disposal to all purchasers of these batteries.

11.3.2.8 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

FIFRA, which was enacted in 1972, addresses mercury, chlordane, DDT/DDE, HCB, lindane and toxaphene. FIFRA provides the authority for banning and restricting the use of pesticides containing these chemicals in the U.S. according to how and where they are used. It requires registration of all pesticides and reporting of any exported pesticides.

11.3.3 Basin-wide and Local Pollution Prevention Initiatives Related to Atmospheric Deposition

Basin-wide, state and local pollution prevention efforts have helped to reduce releases of critical pollutants, thereby reducing the amount available for long-range transport and atmospheric deposition.

- The Great Lakes Binational Toxics Strategy - See discussion in 11.3.1 International Activities.

- U.S. EPA-American Hospital Association Memorandum of Understanding - This Agreement calls for the 30 percent reduction by 2005 of mercury and dioxins-containing wastes. The ultimate goal is virtual elimination of these two toxic substances.

- Pesticide Clean Sweep Programs - States have addressed the problem of accumulated unwanted pesticides by establishing waste pesticide collection and disposal programs, commonly called "Clean Sweeps." These programs provide a simple way to properly dispose of unwanted pesticides at little or no cost to the participants.

- Cook County PCB & Mercury Clean Sweep Partnership - Because mercury and PCBs may be released throughout the disposal process B from the point of disposal, the garbage truck, a transfer station, and the solid waste landfill B the PCB & Mercury Clean Sweep Partnership in Cook County, Illinois is attempting to reduce the amount of PCB- and mercury-bearing equipment entering the municipal solid waste stream. The PCB & Mercury Clean Sweep Partnership is a voluntary, public-private initiative to educate and motivate small business operators, particularly electrical and demolition contractors, to manage and dispose of mercury- and PCB- bearing equipment in an environmentally responsible manner. Training programs, training materials, and a hotline are provided to small businesses and local agency field personnel to assist in identifying, handling, transporting, and disposing of mercury- and PCB-bearing equipment.

- Michigan Mercury Pollution Prevention Task Force - The Michigan Mercury Pollution Prevention task force, which first convened in August 1994, has been active in many mercury pollution prevention activities throughout Michigan. Significant accomplishments include (1) a household hazardous waste collection program in 22 counties sponsored by the Michigan Department of Environmental Quality (MDEQ), resulting in the collection of 200 pounds of mercury; (2) distribution of 16,000 copies of the "Merc Concern" brochure throughout Michigan; (3) development of a mercury pollution prevention web page at http://www.deq.state.mi.us/ead/p2sect/mercury; and, (4) distribution of mercury outreach materials to science teachers.

- Minnesota Mercury Reduction Initiative - In 1997, the Minnesota Pollution Control Agency (MPCA) began the Mercury Contamination Reduction Initiative, aimed at reducing mercury contamination in fish in Minnesota lakes. A major part of this effort is to receive advice and comments from the public regarding the goals of the initiative. The MPCA established a Mercury Advisory Council that includes representatives from government, business, and environmental groups. Based on the results of a two-year MPCA advisory council process, the 1999 Minnesota legislature passed a mercury reduction law that sets specific mercury reduction goals, lists reduction strategies, and requires progress reports to the legislature in 2001 and 2005. The legislative goal is to reduce mercury releases in Minnesota by 60 percent by the year December 31, 2000 and by 70 percent by December 31, 2005, using 1990 levels as a baseline. The reduction strategies include increased enforcement of mercury product laws and other product-related programs, increased research and inventory development, and continued involvement in national and international efforts. The law also requires the MPCA to develop and solicit voluntary mercury reduction agreements from major mercury sources in the State. The voluntary agreements are supposed to stimulate the private sector to come

up with their own innovative, cost-effective ways to reduce mercury releases, in part, by minimizing direct "command and control" regulations and bureaucracy. Experimental reduction techniques and innovative research efforts are encouraged. Guidelines have been deployed for the voluntary program, and mercury sources are expected to submit letters of intent to participate by January 2000 and submit proposals by April 2000.

- Western Lake Superior Sanitary District (WLSSD) Pollution Prevention Efforts - The WLLSD is the is the largest wastewater treatment facility that discharges to the Lake Superior watershed. The WLSSD developed a multimedia mercury zero discharge pilot project with hospitals, clinics, educational institutions, laboratories, and dental practices. As part of this effort, WLSSD partnered with the Northeast District Dental Society to develop recycling procedures for materials containing amalgam particles. In the first year of the project, over 500 pounds of waste material containing amalgam was collected for recycling.

- Michigan Auto Project - This voluntary partnership between DaimlerChrysler, Ford, and General Motors with the MDEQ is modeled on the national U.S. Auto Project which Federal EPA concluded in 1998. The program focuses on expanding pollution prevention initiatives within their respective organizations, and with the assistance of MDEQ promote pollution prevention (P2) concepts among automotive suppliers and supporting industry in Michigan. The automakers will develop case studies highlighting successful prevention efforts at the plant level and publish an annual report which will quantify measurable results as reductions in the use, generation, and release of persistent toxic substances, like mercury, PCBs, and halogenated solvents and other pollutants of concern. A summary may be found on the agency's web site: *http://www.deq.state.mi.us/ead/p2sect/auto.*

- Great Lakes Basin Mercury Source Inventory - A New York State Great Lakes Basin Mercury Source Inventory has been developed and submitted to the U.S. EPA by the New York State Department of Environmental Conservation (NYSDEC). Data for this inventory were compiled from many different data sources including existing permit information, federal and state emission factors, stack test results, annual waste generator reports, and the U.S. EPA Mercury Study Reports to Congress. Medical waste incinerators have been selected as the industry sector that has significant potential for mercury source reduction. Nearly 400 pounds of mercury is emitted to the air annually from 13 medical waste incinerators located in New York State's portion of the Great Lakes Basin. A program to educate and assist this industry sector in mercury source reduction activities is being developed and implementation will follow.

- Automotive Mercury Switch Collection and Recycling Project - This innovative pilot project, sponsored by the NYSDEC, is focusing on the collection and recycling of mercury switches from the hoods and trunks of automobiles. The project will prevent an estimated 500 pounds of mercury from entering the Great Lakes Basin mostly from crushing and shredding operations at scrap and salvage yards. The goal is to remove 250,000 switches from vehicles in the major population centers of New York State's portion of the Great Lakes Basin.

- Voluntary Agreement with Northwest Indiana Steel Mills - The Lake Michigan Forum, U.S. EPA, the Indiana Department of Environmental Management signed a voluntary agreement

with three northwest Indiana steel mills to reduce and eventually eliminate, when possible, sources and uses of mercury in their facilities. The mills have inventoried sources of mercury and are now developing facility-specific plans for mercury pollution prevention.

11.4 SCIENCE DEVELOPMENT

Canada and the United States have invested in the development of a sound scientific framework to connect atmospheric deposition to water quality. This framework relies on a balanced effort of emission inventory development, deposition modeling, and ambient monitoring to provide input to a multi-media mass balance model which will assess the need for further emission reductions. To support the improvement of the Region's information base related to the sources, transport and fate of air toxics in the Great Lakes region, U.S. EPA, Environment Canada, the Great Lakes States, and the Province of Ontario together with their partners have initiated the following activities:

Sources and Emissions

- Great Lakes Regional Air Toxics Emissions Inventory - This project conducts a periodic emissions inventory of toxics pollutants from point, area, and mobile sources in the eight Great Lakes States and Ontario. The inventoried pollutants are contributors to the contamination of the waters and urban areas of the Great Lakes region. The project evolved to meet the goals of the 1986 Great Lakes Toxic Substances Control Agreement (signed by the Great Lakes States' governors and Premier of Ontario), the U.S. EPA's Great Waters Program and other sections of the CAA Amendments. This project is a partnership between the eight Great Lakes States, the Province of Ontario, and the U.S. EPA, and is managed by the Great Lakes Commission. The objective of the project is to present researchers and policy makers with detailed basin-wide data on the sources and emission levels of air toxic contaminants. The project has produced two pilot inventories of 1993 data, a baseline inventory of 1996 data of 82 toxic air pollutants, and is now compiling inventories of 1997, 1998, and eventually, 1999 data covering 188 pollutants. Information on the project may be found at *http://www.glc.org/air/air3.html*

- Identification of sources of banned and current use pesticides to the Great Lakes - Atmospheric measurements are being made in geographical regions which may be sources of chemicals of concern to the Great Lakes .In addition, the residual amounts of pesticide e.g. toxaphene are being measured to assess their significance as a continuing source to the Great Lakes. This assessment includes studies on the exchange of these pesticides between air and soil so that emission rates from soil can be calculated. In addition, certain physical and chemical characteristics of pesticide can be used to determine whether the pesticide levels seen in the Great lakes Basin are the result of fresh or historical emissions. These measurements are being conducted by Environment Canada and also being sponsored by the Federal Governments Toxic Substances Research Initiative [TSRI] and the Great Lakes Program.

- Sources of PCBs to the Atmosphere in Southern Lake Michigan - The objectives of this project are to (1) examine all of the PCB data collected recently in and around southern Lake Michigan (SLM) to determine if source areas associated with high levels of PCBs in SLM can be determined; (2) calculate the amount of PCBs input to the atmosphere in the SLM region; and (3) characterize known local sources and determine if they are significant sources of PCBs.

- Emissions of mercury from coal fired utilities and smelter contribute to mercury levels in the basin. Measurement of mercury in its various forms in industrial emissions is being carried using research aircraft instrument to measure different mercury species. Measurements are being made in southern Ontario and northern Quebec. These measurements are part of a joint Government/Industry/University research program on Metals in the Environment [MITE] and are being sponsored by the Federal Government Toxic Substance Research Initiative as well as the Mining Association of Canada and Ontario Hydro.

- Mercury levels in the atmosphere reflects emissions both from anthropogenic sources as well as from natural sources. Estimates of the contribution from natural emissions are being made by measuring mercury fluxes from mercury-rich and background level soils in Ontario.

- Fugitive Mercury Emissions from Non-combustion Sources in the Great Lakes Region (FuME Study) - The overall objective of this study will be to assess speciated mercury emissions from non-combustion sources in the Great Lakes region. This will include measurements of fugitive air emissions, release of organo-mercurials, presence of airborne reactive gaseous mercury, determination of surface emissions from potentially contaminated on-site soils, and an examination of mercury in annular tree rings near these sources. The sources chosen for the study will be selected in consultation with the Great Lakes States and Region 5, as the study will compliment the Great Lakes States proposals referenced above.

- Identification of Atmospheric Mercury Sources in the Great Lakes' States Through an Ambient Monitoring Program - The objective of this study will be to further identify and quantify mercury air sources within the Great Lakes States and to share this data within the Great Lakes region and beyond. Funding for this project will go primarily to the purchase of 2, state-of-the-art, continuous mercury vapor ambient air analyzers, which will be used to measure mercury downwind from sources, and will be shared among the 8 Great Lakes State on a rotating basis.

- **Spatial and Temporal Variation in Atmospheric Levels**

- Integrated Atmospheric Deposition Network - IADN is a joint U.S./Canada monitoring network is designed to assess the magnitude and trends of atmospheric deposition of target chemicals including PCBs, chlorinated pesticides, PAHs, and trace metals such as lead and mercury. In addition to the 5 master station sites on each of the Great Lakes, the network has a number of satellite sites including one in the Chicago downtown area and several in the Province of Ontario.

- In addition to IADN, the spatial and temporal variation in the atmospheric levels of various substances is being described by the use of passive samplers which integrate the atmospheric levels over longer time periods. This technique will make use of existing measurement stations throughout the basin.

- New or emerging chemical threats to the Great Lakes ecosystem are being addressed by the continued development of sampling and analytical techniques for the atmospheric levels of chemicals of concern. Such chemicals include the chlorinated paraffins, haloacetic acid, polychlorinated naphthalenes and polybrominated diphenyl ethers [flame retardants].

- Concentration of DDT in in the Soil and Air of South Haven, Michigan - The Michigan Department of Environmental Quality is conducting a study of levels of DDT in the soil and air of South Haven, Michigan, a major fruit-growing area on Lake Michigan. Atmospheric levels of DDT near South Haven were found to be 20 times greater than concentrations detected elsewhere in the Great Lakes Basin. The ratio of DDT to its breakdown product, DDE, in soils and air indicate that the high levels are due to historical use of the pesticide DDT on fruit crops. Another suspected source of DDT to the Great Lakes is long-range transport from Mexico, where DDT was used until recently for malaria control. It is expected that this project may provide some insight on the role of long range transport versus local sources of pollutants like DDT to the Great Lakes.

- As part of the Canadian Atmospheric Mercury Measurement Network (CAMNet) measurements of atmospheric mercury are being made at Canadian IADN master stations. Differences in the spatial and temporal variation in mercury levels are being used to infer differing source contributions to the atmospheric levels.

- Mercury Methods Development for Investigating Sources, Transport, and Deposition in the Great Waters - This research project (similar funds as above) was a 2 year mercury monitoring program at 10 sites in the Great Lakes basin. The information acquired from this project will be used to further refine atmospheric sampling methods, examine environmental factors that influence dry deposition and air/water exchange of mercury, and investigate the major source areas and types of atmospheric mercury being deposited in the region.

- Transport and Deposition of Atmospheric Mercury and Mercury Compounds in the Great Lakes Region - The overall objective of this study will be to assess the magnitude and seasonal variation of atmospheric mercury in the Great Lakes region by continuing monitoring sites in 2 sites in Michigan (Pellston and Dexter). The data to be collected represent the only long-term mercury data base (including reactive gaseous mercury data) with which to evaluate changes in emissions patterns and for model evaluations. The data will also provide quantitative information on the source contribution to the wet and dry deposition.

- Urban Contamination of Great Waters: Atmospheric Exchange over Lakes and Oceans - This research project, which was co-funded by ORD, GLNPO and OAQPS, analyzed the contribution and significance of urban contaminants from Chicago and Baltimore to the

atmospheric concentration and deposition in Lake Michigan and Chesapeake Bay respectively. The pollutants measured included particles, metals, selected pesticides and other persistent organic pollutants. One of the main conclusions of this study is that urban areas have a significant impact on the pollutant loadings to adjacent lakes. Similar measurements are being made in Toronto to assess the impact of urban areas on Lake Ontario as part of a research program sponsored by the Federal Governments Toxics Substances Research Initiative and the Canadian Great Lakes Program.

- Measurements of mercury in precipitation are currently being made as part of the Mercury Deposition Network (MDN) . The intent of this network is to describe the spatial and temporal variation of mercury in rain and the network includes both US and Canadian sites.

Atmospheric Transport Modeling

- A global atmospheric circulation model is under development by the Meterological Service of Canada (Environment Canada) to asses the contribution of mercury from world- wide and regional sources of mercury levels to the Great Lakes.

- Investigation of Source-Receptor Relationships from Atmospheric Deposition of Mercury to the Great Lakes - The overall objective of this study will be to develop, test, and perform analyses with the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to estimate source-receptor relationships for atmospheric deposition of mercury to the Great Lakes and to refine mercury emissions inventory information.

- Regional and North American contributions of lead and cadmium to the Great Lakes are being calculated the BLFMS model. This atmospheric transport model developed by Environment Canada has a high spatial resolution and can resolve local issues such as the influence of lake breezes on metal distribution. Source receptor relationships for atmospheric deposition of metals is the ultimate aim of this dynamic modelling activity.

Multi-Media Efforts

- Lake Michigan Mass Balance Study - The objective of the LMMB is to determine the relative loading rates of toxic pollutants from major source compartments (tributaries, atmosphere, sediments, etc.) to gauge progress and predict target load reduction efforts. From 1994 to 1995; simultaneous air, water, and sediment samples were collected in order to develop mass balance models for PCBs, trans-nonachlor, atrazine, and mercury.

- Using Avian Piscivores as Ecological Indicators of Methyl mercury and PCB Availability in Michigan - The overall objective of this study will be to use selected piscivorous birds as ecological indicators for multiple geographic and ecological scales in MI and eventually the entire Great Lakes region. Samples will be collected and analyzed from bird feathers, blood and eggs, in addition to fish and water column samples to develop a risk assessment of piscivorous birds exposure to PCB and mercury exposure.

11.4.1 Data Gaps Identified

Even though considerable resources and efforts have been expended in characterizing and reducing the atmospheric deposition of several key pollutants of concern, some information gaps still limit the ability to fully and reliably quantify the link between atmospheric deposition and concentrations found in water, sediments and biota (especially fish), determine the relative portion of deposited pollution that ultimately contributes to adverse effects, and identifying the air sources responsible for emitting the pollutants of concern which are subsequently deposited to the waterbody in question. These data gaps include:

- Improved emissions inventories of both natural and anthropogenic sources. Specifically, more research is needed to improve emission factors, identify the chemical species of each pollutant emitted (especially for mercury), and identify and quantify the emissions from non-traditional air sources which may not be currently and accurately represented in the emissions inventory.

- Ambient and atmospheric deposition monitoring data for pollutants of concern often lack the appropriate spatial and temporal scales to be able to quantify loadings to all waterbodies and to calibrate and validate atmospheric transport and deposition models. In addition, for some pollutants (e.g. mercury) it is important to monitor for the pollutants various chemical species to aid in source attribution analyses.

- Collection of concurrent air and open water measurements (perhaps requiring a semi-permanent floating platform) in order to obtain water concentration data for air-water exchange calculations, the impact of discrete plumes on the lakes, and over-water turbulence structure measurements for deposition modeling.

- Development of new techniques for direct air-water exchange measurements.

- Better understanding of the role of transformation processes on certain pollutants once they are released to the atmosphere, a phenomenon which can increase a pollutants toxicity and persistence in the environment.

- Determination of physical-chemical constants, deposition velocities, air-water and air-soil interactions, mass transfer coefficients for air-water exchange, air particle partitioning and atmospheric degradation pathways and mechanisms for each of the pollutants of concern. Improved estimates for all these parameters will help develop more robust atmospheric transport and deposition models and will better estimate atmospheric loads to a waterbody from ambient measurements.

- Measurement of complete particle size distributions including how they change over time and space.

- Better characterization of indirect deposition, especially the significance of the watershed in the transport and transformation of pollutants deposited over land.

- Exploration of the fate of deposited compounds in the water column.

- Better understanding of the risks associated with pollutant exposure to human health and wildlife.

11.5 AIR DEPOSITION / WATER QUALITY MANAGEMENT APPROACH

An Air Deposition / Water Quality Management Approach can also be used to gauge the impact of reducing air pollution on the water quality of the Great Lakes from the variety of environmental programs already discussed in this chapter.

As Figure 11-3 shows, an emissions inventory must be created for the pollutant in question. After emissions are reduced (through Federal, State, or other regulations, or through voluntary efforts) and a post-control emissions inventory is developed, atmospheric loadings to the waterbody are estimated with the use of air dispersion and deposition models. The atmospheric loadings estimates, which are validated and adjusted accordingly with air deposition monitoring data, are then inputted to a mass balance model to determine the atmosphere's relative contribution to a waterbody's total loading. The challenge then of the environmental manager is to weigh the inputs of pollutants from all sources (land, air, water, and sediments) to the lake, and to arrive at a mixture of regulations and programs in all these media that result in a coordinated strategy for achieving high ecosystem quality, and maintaining it into the future.

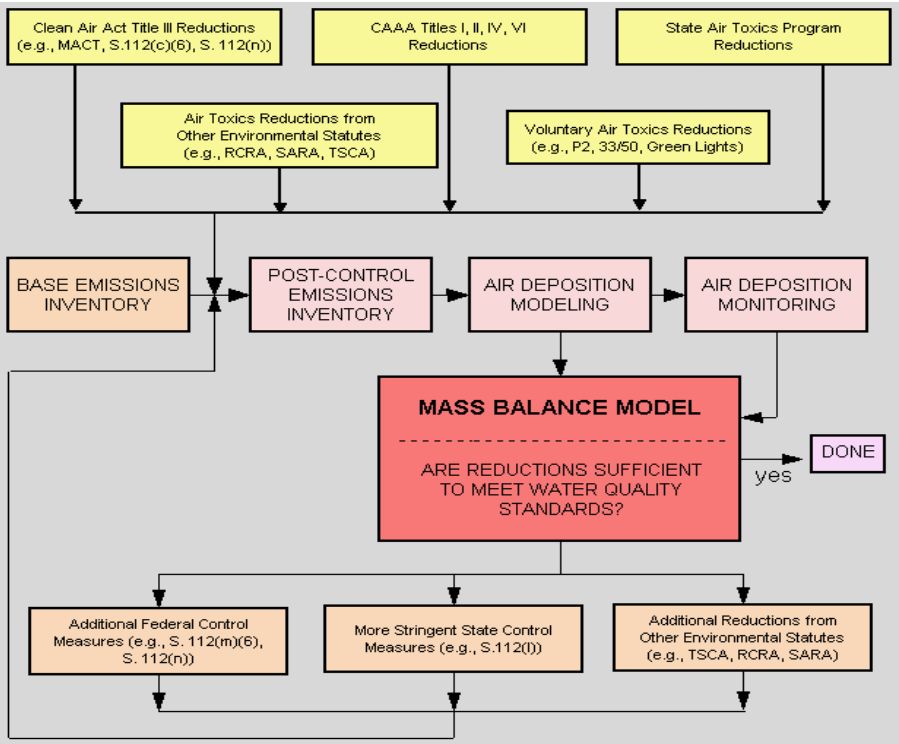

Figure 11-3. Air Deposition/Water Quality Management Approach

11.6 POLICY RECOMMENDATIONS AND/OR NEEDED ACTIONS

We expect that many of the previously-mentioned ongoing and scheduled future regulatory and voluntary programs will further reduce the impact of air deposition. Additional general policy recommendations and actions that can be taken include the following:

- U.S. EPA and Environment Canada will encourage the states and province of Ontario to take innovative measures to address local air sources of targeted pollutants. This may include local burn barrel pollution prevention projects, and mercury collection projects.

- The U.S. EPA will continue to provide leadership in reducing the transboundary transport of critical pollutants, including mercury, PCBs, DDT and others by pursuing reduction goals in the Binational Strategy, the CEC Action Plans and other efforts.

- Specifically, the Lake Superior partners should become more involved with these national and international efforts to reduce pollutants of concern which are not emitted by U.S. sources (e.g. canceled substances like Toxaphene and DDT). This could include appointing representatives to become involved on the Persistent, Bioaccumulative and Toxic (PBT) Strategy or the efforts listed above.

- The U.S. EPA, EC and the state and provincial partners will establish better coordination and integration with the Binational Toxics Strategy so that efforts and resources are leveraged toward the common goal of reducing and eliminating critical pollutants from out-of-basin sources. This effort could include helping to co-sponsor workshops and conferences, research projects or monitoring efforts.

- The U.S. EPA will continue to support, through the CEM or GLNPO funding process, valuable pollution prevention projects such as Clean Sweeps and the Dioxin Burn Barrel Project, both of which will have direct immediate effects on reducing the amounts of pollutants available for atmospheric transport.

- The U.S. EPA and state and federal partners will better coordinate with other ongoing LaMP efforts to address atmospheric deposition. This includes building on and working with the efforts already started on the Lake Michigan LaMP, i.e., the Lake Michigan Mass Balance and the work being done with the Delta Institute.

- The Lake Superior partners will work to Increase public awareness and education of the problem of air deposition and transport. Local initiatives and actions will be encouraged and to the extent resources are available, funded.

- The U.S. EPA and EC will continue to support joint work with states and industry to fill gaps in source categories and further refine emissions methods for critical pollutants.

- U.S. EPA commits to ensuring that all Region 5 states will have enforceable regulations and the permit applications that are required to be submitted for municipal waste combustors and for hospital/medical/infectious waste incinerators by December 2000. Moreover, U.S. EPA commits to pursuing a strategy for assuring 100 percent compliance with these regulations. As regulatory deadlines approach for installation of needed emissions controls, compliance will lead to significant reductions of various pollutants of concern, including mercury. This strategy will involve close coordination including an effort to expedite State rulemaking as appropriate.

- U.S. EPA Region 5 will support the rigorous development and refinement of the Regional Air Toxics Emissions Inventory of all hazardous air pollutants, including those of concern to the Great Lakes and other inland water bodies and which have a tendency to bioaccumulate. U.S. EPA will work closely with all eight Great Lakes states to assure every possible known source of all magnitudes of emissions are identified and that good emission estimates are developed and updated to reflect implementation of control technologies and progress in emission reductions for input to air dispersion and deposition models. This will ensure that a process can occur to assure that regulations and/or P2 initiatives can be developed for environmental improvement.

- U.S. EPA Region 5 will support and pursue activities that result in reductions of mercury emissions. In particular, by the end of 2000,

a) U.S. EPA will publicize, including through posting on its web site, information on how to develop a mercury reduction plan at a manufacturing plant. This information will include mercury reduction plans developed at three steel mills under a voluntary agreement between the mills, U.S. EPA, the Indiana Department of Environment, and the Lake Michigan Forum.
b) U.S. EPA will provide funding to support workshops in at least one Lake Superior basin State on how to reduce the use of mercury-containing devices at electric utilities.
c) U.S. EPA will develop and distribute through the Binational Toxics Strategy mercury workgroup a package of information related to mercury reduction at schools, including advice on how to eliminate mercury from school laboratories.
d) U.S. EPA will make a determination about whether to regulate mercury emissions from electric utilities.

- U.S. EPA will complete the pilot projects to establish TMDL allocations for two waterbodies receiving mercury from atmospheric deposition in order to evaluate the integration of air and water program technical tools and authorities and to examine emission reduction options.

- The U.S.EPA has committed approximately $6 million in FY2000 and FY2001 funds to support mercury research in a number of priority areas including transport, transformation and fate; and human health and wildlife effects of methyl mercury. These research activities are aimed at reducing the uncertainties currently limiting the Agency's ability to assess and manage mercury and methylmercury risks. Although not limited to utilities, a particular

target of research will be collection and analysis of information on mercury emissions and control options for coal-fired utilities in order to support OAR's mandate for a regulatory determination on mercury controls for utilities by December 15, 2000.

- In November 1999, EPA filed civil complaints against seven electric utility companies operating coal-fired power plants in the Midwest and Southeast, charging that 32 of their plants failed to control emissions of oxides of nitrogen and sulfur as required under provisions applicable to modified sources under the CAA. Resolution of these complaints could provide an opportunity to promote solutions that reduce emissions of mercury and other pollutants, as well as of nitrogen and sulfur.

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